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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 6 : G02B 7/182, B23K 26/04

A1

(11) International Publication Number: **WO 98/47035**

(43) International Publication Date: 22 October 1998 (22.10.98)

(21) International Application Number: PCT/NL98/00210

(22) International Filing Date: 14 April 1998 (14.04.98)

(30) Priority Data:

1005799	11 April 1997 (11.04.97)	NL
1008653	20 March 1998 (20.03.98)	NL

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(81) Designated States: AL, AM, AT, AT (Utility model), AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CU, CZ, CZ (Utility model), DE, DE (Utility model), DK, DK (Utility model), EE, EE (Utility model), ES, FI, FI (Utility model), GB, GE, GH, GM, GW, HU, ID, IL, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SK (Utility model), SL, TJ, TM, TR, TT, UA, UG, US, UZ, VN, YU, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).

Published

With international search report.

Before the expiration of the time limit for amending the claims and to be republished in the event of the receipt of amendments.

(54) Title: LASER BEAM MOVING SYSTEM, E.G. LASER MARKING SYSTEM

(57) Abstract

Laser beam moving system comprising a laser beam source, laser beam deflecting means to scan the substrate with the laser beam, control means for controlling the laser beam deflecting means such that the laser beam will scan the substrate in a predetermined manner, and optionally laser beam focussing means to focus the laser beam onto the substrate. It preferably provides a laser beam spot on the substrate that is powerful enough to permanently mark a substrate. Its laser beam deflecting means are adapted to deflect the laser beam over an angle of at least approximately 5°, preferably more than approximately 10°, preferably comprising at least one actuator of the linear type, preferably of the magnetostrictive type, while preferably adapted to deflect the laser beam in two orthogonal directions.

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Title: Laser beam moving system, e.g. laser marking system.

This invention relates to laser beam moving, in particular laser cutting or marking or engraving or imaging. In laser cutting, the laser beam penetrates the substrate preferably at least over a substantial depth or even cuts completely through it, e.g. to cut the substrate into pieces. In marking or engraving or imaging, a substrate is provided with an preferably at least substantially permanent mark, like a symbol or pattern or image, e.g. a two-dimensional mark, however it is possible as well that the laser beam merely provides a temporary image on the substrate, e.g. for entertainment purposes, e.g. during "writing in the air" wherein the image is projected on a substrate e.g. clouds high in the air, providing a depiction of the inage in visual light, to be seen by humans. Furthermore, the invention relates to laser writing. As such, laser writing differs from laser dot matrix marking in that in laser writing the mark is not made from a fixed rectangular pattern of dot positions of fixed dimensions, but instead by free controlled movement of the laser beam and the substrate surface with respect to each other both longitudinally and crosswise. While with dot matrix marking the laser beam is intermittendly fired during its movement over the substrate to provide a pattern of mutually spaced dots on the object, in laser writing the laser beam is continuously fired to provide continuous lines rather than dots. The invention not only improves the quality of the mark, but the possibility of keeping the substrate in a fixed position during marking as well. However, the invention is applicable to other types of laser beam marking as well, e.g. with movement of the laser beam over the substrate in the one direction and movement of the substrate with respect to the laser beam in the perpendicular direction. More preferably, the invention relates to laser marking in which the laser beam makes the mark directly on the substrate to be marked. As such, there is preferably no transfer of an image made by the laser beam towards the substrate to be marked like in prior art laser printing apparatusses in which a laser beam writes a latent image on a trans-

fer means like an electrostatic image drum, after which the image is transferred from the drum to the substrate to be marked. More preferably, the invention is concerned with marking non-flat or three dimensional objects like parcels, boxes, crates, trays that preferably move on a conveyor and pass a marking station comprising the present laser marking system in a continuous moving or intermittendly moving fashion.

The invention is primarily directed to making marks that can be discerned by the human eye. On the other hand, the invention is primarily directed to making permanent or substantial permanent marks. However, it is contemplated that some or all of the ideas of the invention are applicable to other fields of application, e.g. in which the laser beam does not mark the substrate though gives it a treatment, e.g. to calibrate patterns on a wafer or to write an electrostatic image.

As such, the system comprises a laser beam source, laser beam deflecting means to scan the substrate with the laser beam, control means for controlling the laser beam deflecting means such that the laser beam will scan the substrate in a predetermined manner, and optionally laser beam focussing means to focus the laser beam onto the substrate. The scanning of the laser beam can e.g. be provided by a computer and a programme in the computer while the computer and its programme can further control the firing of the laser, if applicable, e.g. when going from the one mark to the other such that the laser does not write a connecting line between subsequent, spaced marks, or if dot-matrix marking is applied to make the several dots for making the mark. However, it is feasible as well to provide a manual control means like a joy stick or one or more keys or a mouse to manually scan the laser beam over the substrate and/or to fire the laser beam. The system can be provided with manual or automatic control means or can have both.

It is appreciated that "firing" the laser beam means the on/off control at low frequency to start and stop the marking. While "firing" the laser beam, it will typically pulsate with a rather high frequency (e.g. approximately 3000 Hz) that is

not or substantially not influencing the marking process. For laser writing, the laser beam is at least substantially continuously fired during writing a mark, e.g. a straight or curved line with or without one or moore loops. If necessary, the laser beam is not fired or only partly fired when crossing a part of a line that was made earlier such that the substrate is not unnecessarily damaged on that spot.

The laser beam used is preferably of the high energy type, e.g. supplied by a CO_2 (appr. 10.6) or Nd:YAG (appr. 1.02) or Eximer (appr. 0.2) or "green" Nd:YAG (appr. 0.51) laser beam source (wavelength in µm between brackets). The energy of the laser beam spot on the substrate is preferably at least one or several MJoules. The laser beam spot on the substrate preferably measures approximately 100 µm. diameter. The laser beam exiting the laser beam source and passing the laser beam deflecting means preferably measures approximately 8 mm. or 10 mm. diameter. Between the exit of the laser beam source and the entrance of the laser beam deflecting means there are preferably no laser beam focussing means. The focussing means are preferably provided between the exit of the laser beam deflecting means and the substrate. There are preferably no focussing means within the laser beam deflecting means. The focussing means can comprise one or more lenses. The focussing means can be of the fixed type or of the controllable type, e.g. to focus on substrates having a different distance from the system.

The laser beam deflecting means can comprise one or more elements that deflect a laser beam that is passing through those elements or that is reflected by those elements or only partially passes through those elements and is only partially reflected by those elements. The laser beam deflecting means can comprise one or more mirrors or mirror surfaces. The laser beam deflecting means can comprise one or more acousto-optic deflectors. The laser beam deflecting means can comprise a combination of one or more mirrors or mirror surfaces and one or more acousto-optic deflectors. The laser beam deflecting means can comprise one or more non-displacing elements that deflect the laser beam in the predetermined direction by

virtue of a changing shape, e.g. curvature or angular position. For this purpose a linear actuator such as an electrical device which undergoes a change of shape in response to an electrical signal e.g. a piezoelectric element or a magnetostrictive element or an electro-strictive element is preferably used with a laser beam deflecting element such as a laser beam reflecting or a laser beam transparent surface. The laser beam deflecting means can comprise one or more actuators of the linear type such as an electrical device which undergoes a change of shape in response to an electrical signal e.g. a piezoelectric element or a magnetostrictive element or an electro-strictive element.

Most preferably, the actuator used with the laser beam deflecting means is of the magnetostrictive type.

It is within the skills of the man skilled in the art to select some other type of actuator applicable with the laser beam deflecting means of this invention on the basis of this disclosure.

Preferably, the laser beam deflecting means are provided such that they provide deflection of the laser beam in two mutually perpendicular directions. This deflection in two mutually perpendicular directions can be done with one or with two or more laser beam deflecting means. Preferably, at least one of the laser beam deflecting means deflects the laser beam over an angle of at least 5°, preferably over at least 10°, most preferably over an angle of at least approximately 15°. Preferably the frequency with which the laser beam can be deflected by the laser beam deflecting means is at least 500Hz, more preferably at least approximately 1000Hz, most preferably at least approximately 2000Hz.

Preferably, the system comprises a correcting apparatus for correcting deviation of the laser beam spot e.g. by correcting deviation of one or more deflecting means. In a preferred embodiment a deviation sensing laser beam, seperate from the laser beam for marking is used. This deviation sensing laser beam is made to deviate from the marking laser beam over a preferably relatively small angle of known magnitude. After deflection by one or more or all deflecting means, this devia-

tion sensing laser beam hits a sensor, preferably comprising a multiplicity of sensor elements in a predetermined pattern, e.g. rectangular matrix pattern, e.g. a CCD-type sensor. The position where the deviation sensing laser beam hits the sensor is a measure for the magnitude and/or direction of the deflection of the laser beam deflecting means. After evaluation in an evaluation means, automatic decision means, like an electronic computing unit, can send a correcting signal to the laser beam deflecting means, possibly via the electronic computing means controlling the laser beam deflecting means.

The substrate or target area can be of any type material that allows writing or marking with a laser beam. While paper or paper based substrates are preferred, wherein the laser preferably burns or colours a mark in or on the substrate, e.g. laminates can be used as well wherein e.g. an upper layer is burnt away or vaporized or dissolved by the laser beam to expose a differently coloured lower layer. The energy of the laser beam can be used to cause a distictive discoloration or to etch or to melt or to cause a distictive alteration of the electrical charge of the substrate or a surface layer or other layer thereof.

By way of example, reference is made to GB-B-2133352 disclosing in one embodiment a laser dot-matrix marking system wherein the output beam of a RF excited wave guide or non-wave guide CO_2 laser is directed through an acousto-optic deflector such that the laser beam is deflected to produce a one-dimension array of pulses that are focussed on an object to be marked, while in another embodiment the acousto-optic deflector is replaced by a mirror arrangement, which may include a multi-faceted spinning mirror or a two mirror system in which one mirror is fixed and the other mirror is displaced by an electronic device, such as a piezoelectric transducer.

By way of further example, reference is made to US-A-5600478 disclosing a laser dot-matrix marking system wherein the output beam of a non specified laser type, firing with predetermined intervals, is directed through a lens and reflected by a first and a second deflecting mirror for moving the beam in the X-direction to be focussed on an object moveable in a

direction perpendicular to the scanning plane of the laser beam and to be marked with the laser beam according to e.g. a 7*5 matrix pattern. It is said that both the first and second reflecting mirror are each mounted on a displacing device that each include an electrical device that receives operating signals from a computer. The electrical devices comprise devices that undergo a change in shape in response to electrical signals and may comprise electrostrictive devices, magnetostrictive devices or piezoelectric devices to effect displacement of the displacing devices. In an embodiment, the displacement device comprises a so-called flexure hinge device. The first and second mirror are moved with fixed frequency and amplitude on a continuous basis wherein compared to the second mirror the frequency is higher and the amplitude is lower for the first mirror. The superposition of the movement of both mirrors results in the laser beam being moved stepwise in the X-direction over the object. In another embodiment according to this US document (figure 4), the laser beam is deflected in one direction by merely one mirror that is actuated by two electrical devices acting with fixed frequency and amplitude on a continuous basis wherein compared to the one electrical device the frequency is higher and the amplitude is lower for the other electrical device such that the superposition of the actuation of both electrical devices results in the laser beam being being moved stepwise in the X-direction over the object. In a further embodiment a single mirror deflects the laser beam in one direction wherein the mirror is actuated by a single electrical device that is supplied with a stepwise increasing voltage to arrive at a stepwise movement of the laser beam over the object again. In a final embodiment a single mirror deflects the laser beam in one direction wherein the mirror is actuated by a single electrical device that is supplied with a continuously increasing signal such that the laser beam smoothly moves over the object. In all cases, the laser beam is fired with predetermined intervals. If the laser beam is moving stepwise, the firing is only during the dwell periods of the laser beam. If the laser beam is moving smoothly as in the final embodiment, the firing is at a number of

preselected signal strengths for the continuously increasing signal to the electrical device such that the firings are spaced apart in the scan direction of the laser beam. This document does not teach any values for the scanning angles of the mirrors. Based on the disclosure, the skilled person can only imagine that it is possible to print one mark of 7*5 dots or a 7 dots high one-liner requiring scanning angles for the mirrors of less than 1°.

DE-C2-4123052 is concerned with an integrated sensor and adjusting element for controlling the position of the focus spot of the processing beam of high performance lasers, disclosing a cooled tilting mirror or cooled mirror with deformable surface as a correction element to correct several types of failures, like angular or focal failures. The actuator for the correcting mirror comprises piezoelectrical or magnetostrictive elements which are directly coupled with the mirror that is supported on a bellows type spring. The high performance laser is used to process an object that is cooled with a fluid. This document does not teach any values for the scanning angles of the correction mirror, however the skilled person will realise that the scanning angle will be less than 1°. Furthermore, this document is silent about the system in which the high performance laser is used and the directions in which the laser beam is moved and does not appear to disclose a laser marking system suitable for making a mark like a symbol or pattern or image on an object or workpiece.

NL-A-1001752 is concerned with a deflector for deflecting a light beam to be used in a scanning device e.g. for confocal microscopy, bar code reading or scanning of documents. It is said that the deflector comprises one or more actuators of magnetostrictive material that move a reflecting element, e.g. a mirror with a diameter of 1.7 mm., via a mechanical transmission. A scanning angle of 17.6° is disclosed. It is said that this deflector is meant to combine advantages of the known galvanometer-scanner, like its relatively large scanning angle, with high scan frequencies of several kiloHerz. This document does not teach that the deflector can be used to work a substrate with a laser beam (e.g. cutting or marking) or for

depicting purposes. This document does not teach that the deflector can be used in a system that provides movement of the laser beam in two perpendicular directions. This document does not teach that it can be used in combination with a further deflector of the same or different type.

US-A-5477023 is concerned with a laser engraving system and method for engraving an image on a workpiece. According to its disclosure, two galvo motors are used to move respective beam deflecting mirrors to controllably direct the pulsed light beam in the X and Y directions, respectively, over the object. The 120 Watts engraving laser beam is provided by exciting a Nd:YAG cristal or CO_2 gas, suitable for engraving "INCONEL 600" surface. A He-Ne laser is provided to emit a monochromatic beam of visible light along the engraving laser beam to allow the operator of the system to readily visually observe the alignment of the engraving laser beam with the workpiece to be engraved.

An object of the invention is to provide a laser beam moving system of relatively cheap construction. An object of the invention is to provide a laser beam moving system which affords relative wide range of scan. An object of the invention is to provide a laser beam moving system which affords high degree of accuracy for the direction of the beam. An object of the invention is to provide a laser beam moving system which affords a relatively fast rate of operation. An object of the invention is to provide a laser beam moving system that is little susceptible to wear and/or stability. An object of the invention is to provide a laser beam moving system with an improved accuracy control system. An object of the invention is to provide a laser beam moving system that allows marking or scanning a relatively large area on a relatively closely spaced substrate. An object of the invention is to provide a laser beam moving system that can make a mark by providing movement of the laser beam in two perpendicular directions, avoiding e.g. the necessity to move the object during marking. An object of the invention is to provide a laser beam moving system that can depict a temporary image, e.g. a visual light projection on a substrate, e.g. a projector shield like a flat

white screen or clouds high in the air, with increased refreshment speed of the depiction resulting in elimination or reduction of flickering of the depicted image. An object of the invention is to provide a laser beam moving system with which it is possible to provide markings that are an accurately copy of "handwritten" signs by the human. An object of the invention is to provide a laser beam moving system with which it is possible to make the movement of the beam at least substantially smooth and preferably without at least virtually any step, preferably copying the movements of a pencil over a piece of paper when a person is handwriting. An object of the invention is to provide a laser beam deflecting means for a laser beam moving system, preferably a laser beam moving system according to the invention.

One or more of the above or other objects are met by the invention as defined in the accompanying claims.

The invention will be further illustrated by way of presently preferred non-limiting embodiments referring to the drawings in which:

Figure 1 is a diagrammatic view of one embodiment of the laser beam moving system;

Figure 2 is a diagrammatic view of another embodiment of the laser beam moving system;

Figure 3 is a diagrammatic view of one embodiment of the laser beam deflecting means;

Figure 4 is a preferred elaboration of the mechanical transmission for the embodiment of fig. 3;

Figure 5 is the actuator used in the embodiment of fig. 3;

Figure 6 is a perspective front view of an elaboration of the embodiment of fig. 3.

Fig. 1 shows a laser moving system 20 designed as a laser marking system comprising a laser beam source 21, a first laser beam deflecting means 22 (comprising a reflecting mirror), a second laser beam deflecting means 23 (comprising a mirror), a focussing means 24 (e.g. a lens) and a computer 25. Figure 1 further indicates an object 26 (e.g. a carton box) to be marked with the laser beam, and the laser beam path 27. The laser beam exiting the source 21 comprises coherent electro-

magnetic radiation with a diameter of approximately 8 or 10 mm., a power of approximately 100 Watts and a pulsating frequency of approximately 3000 Hz. Different diameters and/or powers and/or pulsating frequencies are feasible as well. The distance between the first and second laser beam deflecting means 22 resp. 23 measures approximately 10 mm. The distance between the focussing means 24 and the object 26 measures approximately 160 mm. The laser beam spot on the object measures approximately 100 µm. The laser beam spot on the object can cover an area of approximately 100 mm. * 100 mm. or more without moving the laser marking system 20 and the object 26 with respect to each other. The first laser beam deflecting means deflects the laser beam in the X-direction and the second laser beam deflecting means deflects the laser beam in the Y-direction, such that the laser beam spot on the object can be moved in both the X- and Y-direction without moving the laser marking system 20 and the object 26 with respect to each other.

In fig. 2 only one laser beam deflecting means 22 is shown that is adapted to deflect the laser beam in both the X- and Y-direction such that the laser beam spot on the object can be moved in both the X- and Y-direction without moving the laser marking system 20 and the object 26 with respect to each other.

In both embodiments, the computer is controllably connected to the laser beam deflecting means 22 and 23 to control the deflection of the laser beam.

At least one and preferably at least two or all laser beam deflecting means of the laser marking system comprise actuators of the linear type to actuate a laser beam deflecting element, e.g. a laser beam reflecting surface. Depending on the type, the actuator can be coupled directly to the laser beam deflecting element, i.e. such that the transmission rate is at least approximately 1:1. However there is preferably some kind of transmission active such that the laser beam deflecting element experiences a preferably substantial amplification of some action of the actuator.

A presently preferred embodiment of the laser beam deflecting

means is shown in fig. 3-6. This embodiment is based on the embodiments disclosed in NL-A-1001752, the disclosure of which is enclosed in here by reference. Fig. 3-6 are identical to fig. 1-4 respectively of NL-A-1001752. The reference signs used in fig. 3-6 are identical to the reference signs used in NL-A-1001752. For a description of the embodiments according to figure 3-6, their components and their action, reference should be made to NL-A-1001752. Extensive research revealed that the teachings of NL-A-1001752 can be used surprisingly to design a laser moving system, e.g. a laser marking system of excellent performance according to the present invention. To get most benefits of the teachings of NL-A-1001752, the following modifications can be made to the embodiments: Different from said NL disclosure, the reflecting element is preferably not circular, e.g. elliptical or rectangular. Its longitudinal and crosswise dimension is preferably substantially larger, e.g. approximately 12 mm.* 6 mm. or approximately 18 mm. * 14 mm. in stead of 1.7 mm. diameter, and the scanning angle of the mirror is preferably at least approximately 20° for which purpose the stroke of the linear actuator measures at least 10µm, preferably at least approximately 15 µm while at present its stroke measures approximately 25 µm. A further difference is that the transmission ratio preferably meaures approximately 1:10. Tests revealed that the mirror can be moved with a frequency of approximately 1 kHz, however it is expected that by further optimization an even higher frequency between 2 and 4 kHz or even higher can be provided. The magnetostrictive elements 7 can be changed for other actuators of the linear type.

Figure 1 further shows a deviation correction apparatus 30 comprising a deviation sensing laser beam source 31, a sensor 32 and an evaluation unit 33. The laser beam path is indicated by 34. The laser beam path 34 upstream from the first laser beam deflecting means 22 deviates from the laser beam path 27 over a small angle. The laser beam path 34 crosses the sensor 32 in stead of the object 26 after deflection by the first and second laser beam deflecting means 22 and 23. Het laser beam source 31 preferably provides a laser beam of different fre-

quency, e.g. low energetic (e.g. HeNe or Ar). Signals from the sensor are send to the evaluation unit 33. If a deviation is found, the evaluation unit sends a correcting signal to the computer 25 that corrects the one or more or all laser beam deflecting means 22, 23.

List of references for fig. 3-6:

1	laser beam deflecting means	2	reflecting element
3	transmission stucture	4	living hinge
5	arm	6	reference part
7	actuator	8	connecting means
9	house	10	rod
11	magnetostricive material	12	coil
13	permanent magnet	14	bias spring

Element 3 is preferably of a titanium alloy, e.g. $TiAl_6V_4$, to be strong and light and fatigue resistant to have a long life and allowing for sparc erosion. Element 3 and/or 2 preferably comprise polymer material, preferably of the liquid christal type (e.g. Vectraan HS®) providing strenght, light weigth and fatigue resistance and possibility of injection moulding, possibly integrally. Element 3 (apart from element 4a that is shown on a larger scale for clarity) is shown to scale. Element 11 comprises preferably terbium, dysprosium and iron, e.g. Terfenol-D® or Magmek® providing a relatively high first resonance frequency allowing use at a higher working frequency resulting in a higher frequency of moving the laser beam; high energy efficiency; and convenient high force at convenient high amplitude during convenient long time. Element 2, that can be a delfecting element as well, preferably reflects or deflects the beam in a wave length independent manner, preferably comprises glass or silicon material preferably with a deposited layer of matal, e.g. aluminium, and is preferably as light as possible. The particular embodiment of element 3 as shown here provides amplification of the amplitude of element 2. By using two actuators 7 and a single axis stucture as shown in fig. 3, each actuator 7 merely has to provide half the required power, while the possible symmetrical structure is easy to fabricate and has twice the stiffness, doubling the first resonance frequency. The arms 5 are preferably tapering

as shown, compensating for lateral displacement of element 2. Element 14 is optionally. The coil 12 provides a magnetic field such that element 11 expands or shrinks. Element 3 is preferably glued to the rod 10 of element 7, providing the required flexibility. Element 2 is preferably glued to element 3 as well.

Further embodiments covered by this invention will be clear to the skilled person when reading this descrition and the appended claims.

MATRIXPRINTER

In another embodiment, the invention is concerned with dot matrix laser engraving providing a dot pattern of 5, 7, 9 or 11 dots close above each other on a straight line, which line is repeated at least two times close near each other. This pattern is according to the prior art provided with a number of laser beam sources that equals the number of dots in the pattern. The laser beam of each laser beam source is led by a seperate laser beam tube to a common transmitting head, projecting the laser light on the target. To get the required dot matrix mark on the target, the laser beams are individually controlled blocked while target and transmitter head are moved with respect to each other. The invention provides a marking method in which the surface of a target is preferavly permanent visibly changed with electromagnetic (e.m.) energy, like visible light or UV-light or IR-light by providing a primary beam of e.m. energy is generated and splitted in a number of at least two secundary beams, wherein said secundary beams are projected on said target in a predetermined pattern while, depending on the required mark, one or more of those secundary beams are possibly blocked such that they do not reach said target in the way a non-blocked secundary beam does. This invention is illustrated as follows in a non-limiting manner:

Fig. 7 shows a laser beam 102 extending (e.g. via one or more glass fibres) from a common laser beam source 100 to a transmitter head 103. The head 103 comprises in this embodiment five so called pixel elements 104 on a stright line close above each other. The beam 102 is, via a lense 106, devided over said elements 104. Viewed in the direction of propagation

of the laser light, each element 104 is followed by a respective passage element 105, e.g. a shutter. The lense 107 projects the light on the object 108, unless the shutter 105 prevents this. The shutter 105 provides passage to the object for the light in its open position, and has a closed position preventing passage to the object, e.g. by strongly disperion or blocking of the laser light. It is meant that the laser light changes the target remarkably, preferably visibly, to make a mark, preferably a permanent mark. If the head 103 and the target 108 do not move with respect to each other, five "spots" of laser light will appear on the target in a straight line one above the other. By moving the target 108 and the head 103 with respect to each other, sereval of those lines, having the dots mutually in line, at a short distance parallel to each other can be made. By "closing" one or more of the shutters 105 during projecting those plurality of lines, e.g. a reading mark can be provided on the target 108 as with a so called matrix printer. In a further embodiment, it is feasible as well to have the primary beam 2 devided in two orthogonal directions in stead of one, such that the head 103 can provide several of those lines of dots next to each other without movement of the head 103 and target 108 with respect to each other. The shutters 105 can be provided upstream from the pixel elements 104 as well. A shutter 105 can e.g. be provided by LCD (liquid christal display) technology, linear actuators like piezo-electical elements possibly combined with mechanical transmission, controlled shutters, magnets, fluid controlled shutters or combinations of those. The shutters are preferably provided such that the light passes therethrough "out of focus". In a further embodiment two or more heads 103 are used such that the mark can be provided on e.g. two sides of the target 108.

CLAIMS

1. Laser beam moving system comprising a laser beam source, laser beam deflecting means to scan the substrate with the laser beam, control means for controlling the laser beam deflecting means such that the laser beam will scan the substrate in a predetermined manner, and optionally laser beam focussing means to focus the laser beam onto the substrate.

2. System according to claim 1, wherein it provides a laser beam spot on the substrate that is powerful enough to permanently mark a substrate.

3. System according to claim 1 or 2, wherein the laser beam deflecting means are adapted to deflect the laser beam over an angle of at least approximately 5°, preferably more then approximately 10°.

4. System according to any of claims 1-3, wherein the laser beam deflecting means comprises at least one actuator of the linear type, preferably of the magnetostrictive type.

5. System according to any of claims 1-4, wherein the laser beam deflecting means are adapted to deflect the laser beam in two orthogonal directions.

6. System according to any of the peceeding claims, wherein the laser beam deflecting means comprises one or more preferably non-displacing elements that deflect the laser beam in the predetermined direction by virtue of a changing shape, e.g. curvature or angular position.

7. Laser cutting or marking or engraving or imaging method using a system according to any of the preceeding claims.

8. Laser beam deflecting means comprising at least one actuator of the linear type.

9. Laser beam deflecting means comprising one or more preferably non-displacing elements that deflect the laser beam in the predetermined direction by virtue of a changing shape, e.g. curvature or angular position.

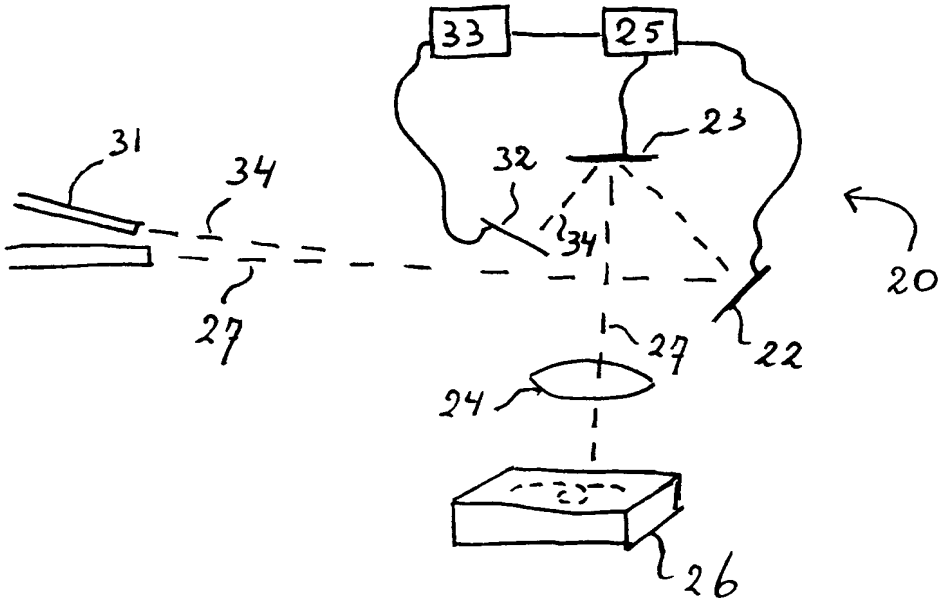

Fig. 1

Fig 2

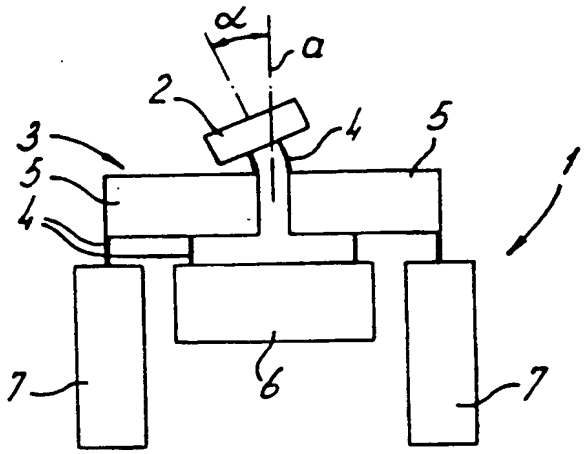

Fig 3

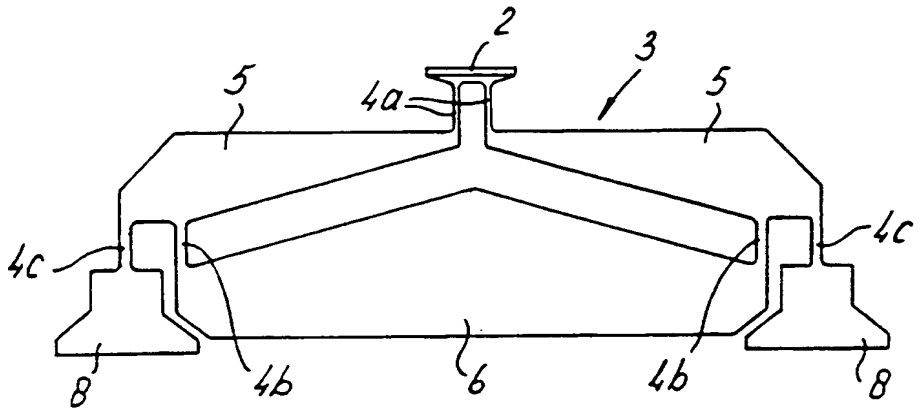

Fig 4

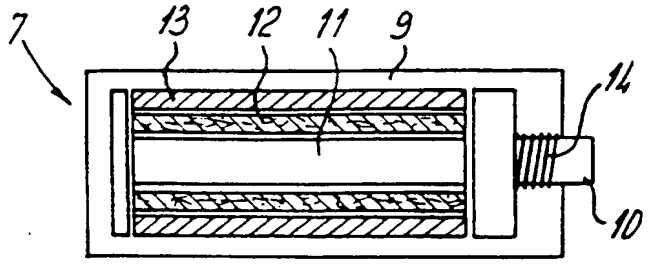

Fig 5

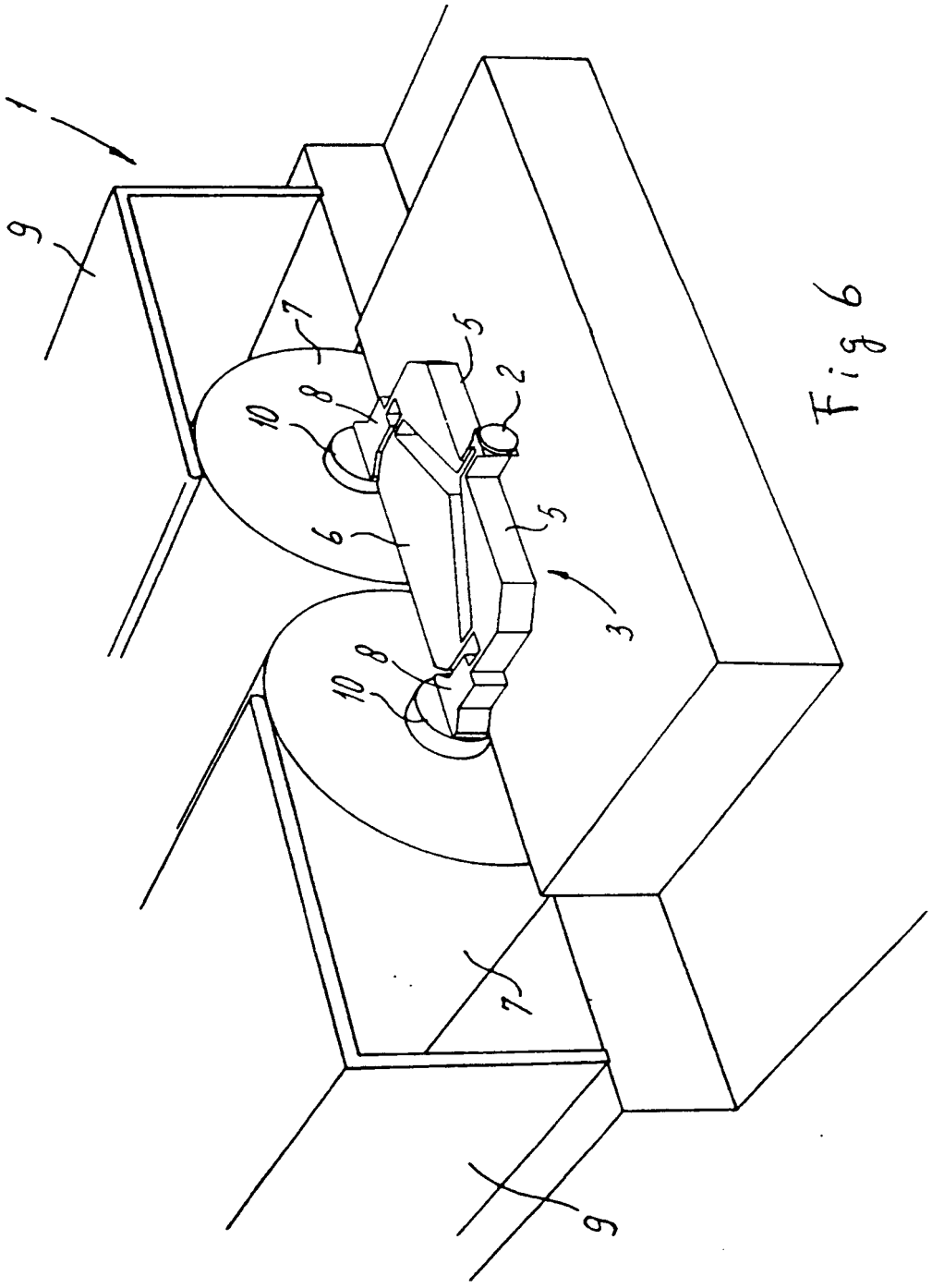

Fig 6

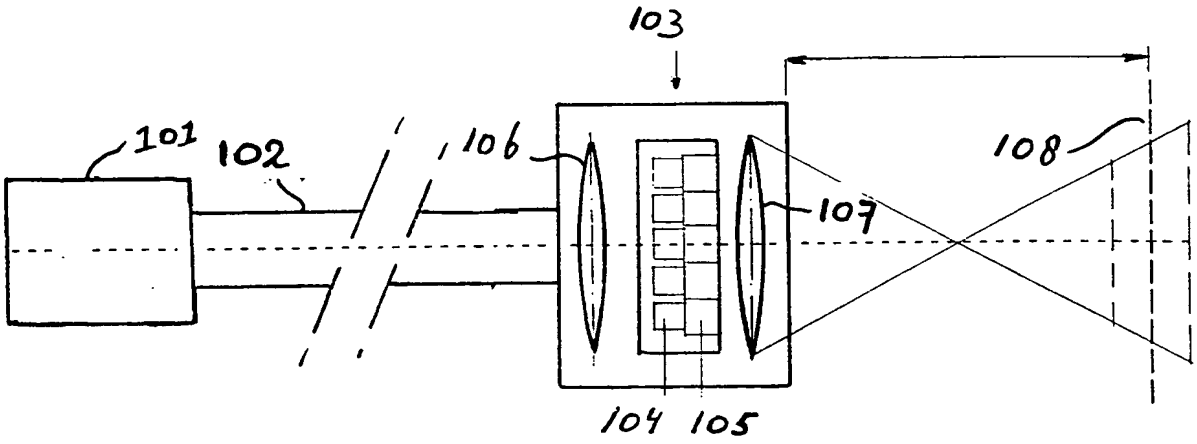

Fig 7

INTERNATIONAL SEARCH REPORT

Inter onal Application No
PCT/NL 98/00210

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G02B7/182 B23K26/04

According to International Patent Classification(IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 B23K G02B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X,P	NL 1 001 752 C (N.O.T.N.O. TNO TE DELFT) 1 August 1998 cited in the application see page 1, paragraph 1 - paragraph 2 see page 5, last paragraph - page 6, paragraph 1; figures 1,3 see paragraph 4	1,2,4, 6-8
Y	WO 97 08376 A (MORRISON TECHNOLOGY LTD) 6 March 1997 see page 11, last paragraph - page 12, paragraph 3; claim 1; figure 1	1-3,6-9
Y	DE 39 27 303 A (MITSUBISHI DENKI K.K.) 22 February 1990 see column 3, line 18 - line 31; figure 1	1-3,6-9

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

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Date of the actual completion of the international search	Date of mailing of the international search report
14 August 1998	26/08/1998

Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

Inte. onal Application No
PCT/NL 98/00210

C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication.where appropriate, of the relevant passages	Relevant to claim No.
A	EP 0 696 875 A (D.F.L.R) 14 February 1996 abstract -----	1-8

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INTERNATIONAL SEARCH REPORT

information on patent family members

Inter onal Application No
PCT/NL 98/00210

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		US 4943147 A	24-07-1990
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		JP 9120036 A	06-05-1997